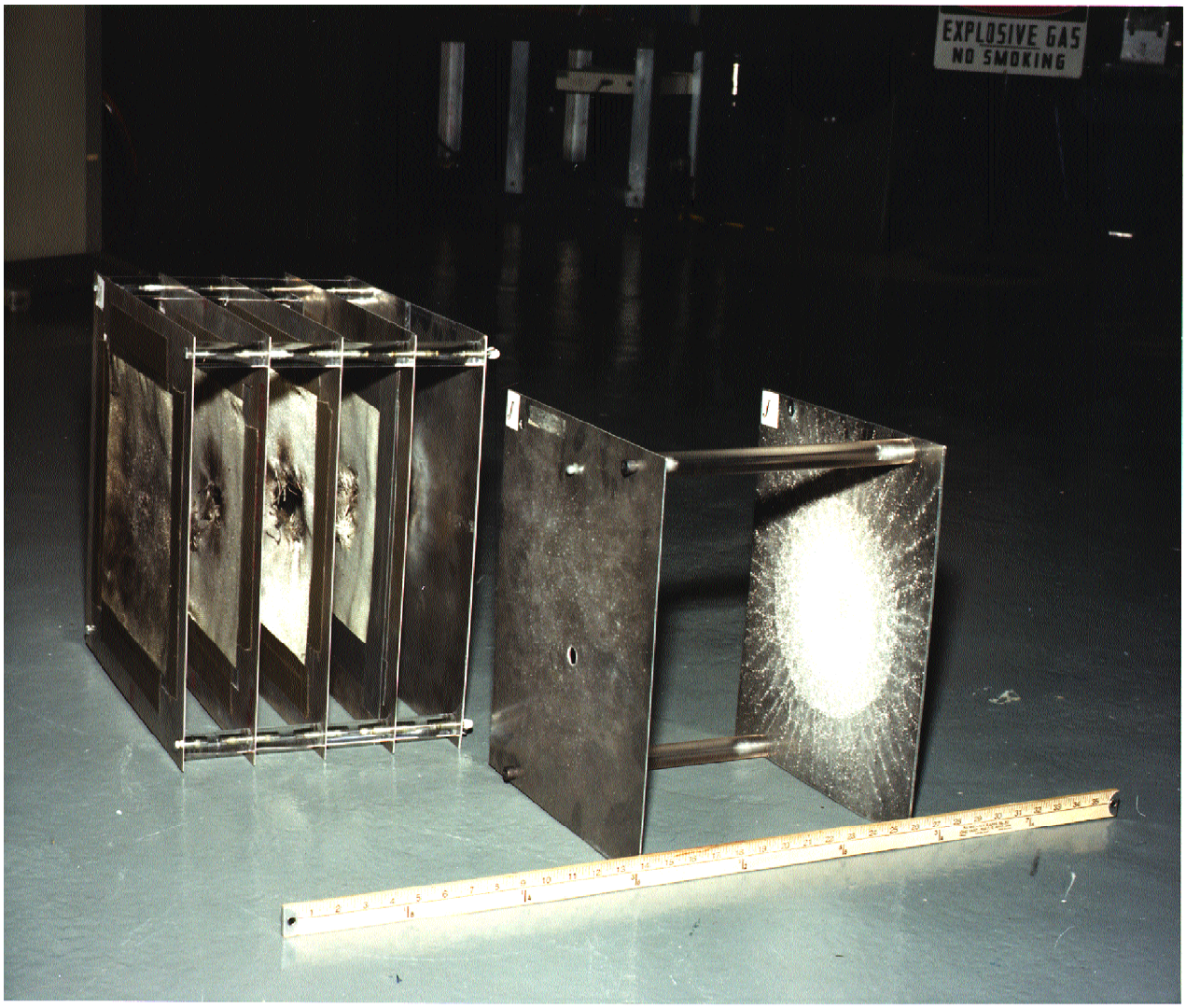
Part Two:

Current Policies and Activities, Options, and Associated Research Needs



The NASA Johnson Space Center Hypervelocity Impact Test Facility (HIT-F) developed and patented a light-weight hypervelocity impact shielding concept called the “Multi-Shock” (MS) Shield. The MS shield in the left of the figure weighs ~one-half of the weight of a conventional Whipple shield that is shown on the right. Each shield was designed to protect from a 1-cm-diameter aluminum projectile at ~7 km/sec impacting straight into the shield. Tests at the JSC HIT-F have demonstrated that the MS shield weighs ~50% less than the Whipple shield while providing equivalent or superior protection at normal and oblique impact angles (i.e., stopping the same or larger projectiles) for velocities in the testable range (up to ~8 km/sec).

Chapter 3: Existing Policies Concerning Space Debris

I. National Space Policy

To date, only one policy statement specifically related to orbital debris has been articulated at the Presidential level. The Reagan Administration approved a policy in February 1988 which included the statement that "all space sectors will seek to minimize creation of space debris. Design and operations of space tests, experiments and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness."

II. Agency Policies

NASA Policy

Perhaps the most significant debris-reduction policy has been the NASA requirement instituted in 1982 for the venting of the unspent propellants and gases from Delta upper stages to prevent explosions due to the mixing of fuel residues. This practice was continued when the Air Force began direct acquisition of Delta launch vehicles and McDonnell Douglas initiated commercial launch services. No U.S. hypergolic stages following this procedure have inadvertently exploded.

NASA Management Instruction 1700.8, Policy for Limiting Orbital Debris Generation, identifies its policy to employ design and operations practices that limit the generation of orbital debris consistent with mission requirements and cost effectiveness and requires each program or project to conduct an assessment demonstrating compliance.

DOD Policy

DOD Space Policy, dated February 1987, expressly addresses orbital debris as a factor in the planning of military space operations. The DOD space policy states:

> DOD will seek to minimize the impact of space debris on its military operations. Design and operations of DOD space tests, experiments and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements.

Air Force (AFMC, Space and Missile Systems Center) regulation SDR 55-1 directs program directors and managers to adjust satellite development and deployment plans to avoid orbital positioning problems.

U.S. Space Command Regulation 57.2, Minimization and Mitigation of Space Debris, requires the assessment of the impact of design and operations measures to minimize and mitigate debris on military space systems.

Other Policies

The National Oceanic and Atmospheric Administration (NOAA), NASA, and several DOD programs boost their satellites which are no longer functional into orbits above GEO to prevent the creation of additional debris by inadvertent collisions with other drifting satellites and to free valuable orbital slots.

All commercial activities subject to Department of Transportation (DOT) authority are subject to the Office of Commercial Space Transportation's regulations established in Chapter III, 14 Code of Federal Regulations (CFR) Part III. These regulations require each applicant to address safety issues with respect to its launch, including the risks of associated orbital debris, on-orbit safety, and reentry hazards.

Study Group 4 of the International Telecommunication Union's Radiocommunication Bureau, in which the U.S. is a participant, endorsed the recommendation that all geosynchronous orbit satellites be boosted not less that 300 km above the geosynchronous orbit at end of life and that the spacecraft then be made inert by discharge of any residual propellants and gases and "safing" of the batteries.[63]

III. Ongoing Efforts

There is a growing recognition within the Federal government that more formal mechanisms need to be established for addressing debris considerations. Efforts to define the problems and to identify options for dealing with them are expanding.

NASA has created an in-house Orbital Debris Steering Group to examine potential NASA policies and procedures and to make recommendations to

the Administrator as to proper approaches to orbital debris problems. Basic and applied research about debris impact behavior and spacecraft shielding is ongoing to provide input to both policy formulation and the design of the International Space Station and other spacecraft.

NASA has established an international coordination working group to exchange data with the other major spacefaring nations. Via these meetings, all other nations have been encouraged to make design and operations modifications to their launch systems to reduce the likelihood of explosions. In addition, these exchanges have led to better understanding of the causes of breakups and appropriate preventive measures.

DOD has created a Space Debris Working Group as a forum to examine and develop policies and procedures and to coordinate space debris activities within the Air Force. Recommendations are provided to the Assistant Secretary of the Air Force for Space.

DOT conducts research activities at the Transportation Systems Center and its contractors. A report, entitled "Hazard Analysis of Commercial Space Transportation (Vol. I: Operations; Vol. II: Hazards; Vol III: Risk Analysis"), devotes explicit attention to orbital and reentry hazards, and to the management of space debris hazards. Current research is aimed at comparing the relative operational space safety and debris type/number characteristics for existing commercial expendable launch vehicles (ELVs), both generically (e.g., typical parking and GTO orbits and orbital life of operational debris) and for specific proposed missions. Further research focuses on the development of rational, risk-based insurance requirements and regulatory standards for the commercial space industry.

DOD and NASA maintain a continuing effort to understand the debris environment and its potential hazard. Coordinated programs of observation and modeling of explosions and collisions and the resulting environment are conducted by both organizations. The research aids satellite and booster program offices by assessing vehicle-specific debris hazards and debris abatement options.

Operating under the Space and Missile System Center Space Test and Experimentation Program Office, DOD has established a tri-service Space Test Range Organization to coordinate and oversee the safe conduct of testing performed in space.